ELEC 460 — Control Theory II

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Due Date: Thursday, 11 January 2018, 11:30 AM **Assignment:** Number 1

1. Sketch the root locus

```
G1 = zpk([],[0,-1,-20],20) % create transfer function
figure(1); rlocus(G1) % Plot root locus
```

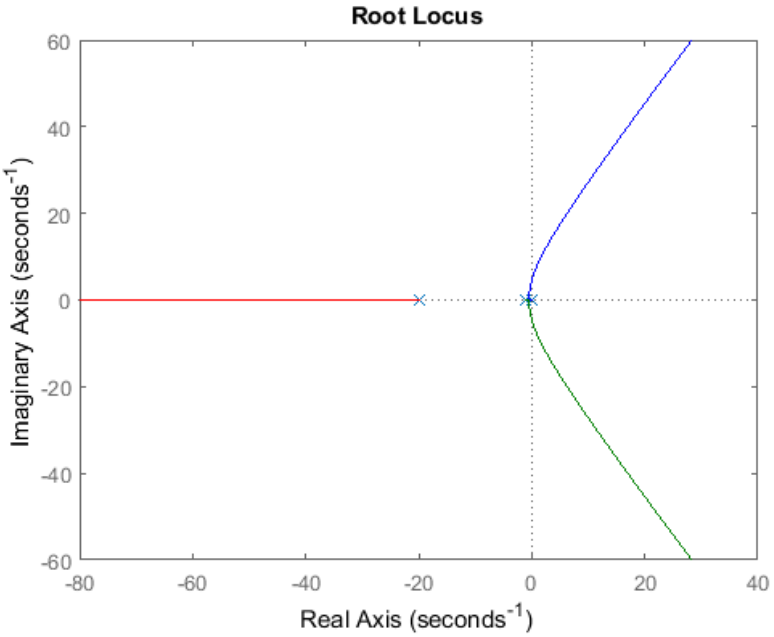

Figure 1: Root Locus when K =1

2. Find Kv.

Using the final value theorem: $x(\infty) = \lim_{s \to 0} sX(s)$

```
syms s ;Kv = limit(s*20/(s*(s+1)*(s+20)),s,0)% compute Kv
    using limits
```

3. Sketch Bode and Nyquist plots.

```
figure(2); bode(G1)
figure(3); nyquist(G1)
```

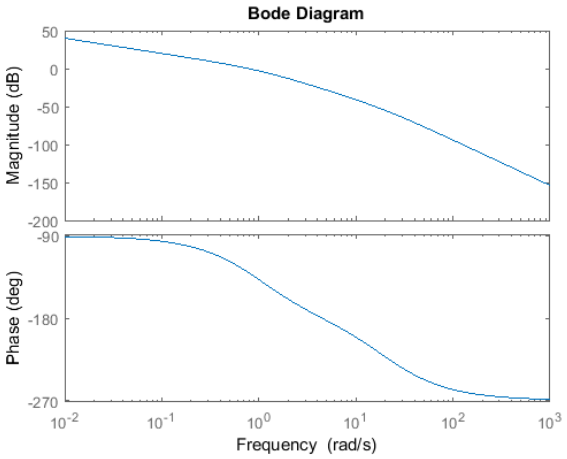

Figure 2: Bode plot when K=1

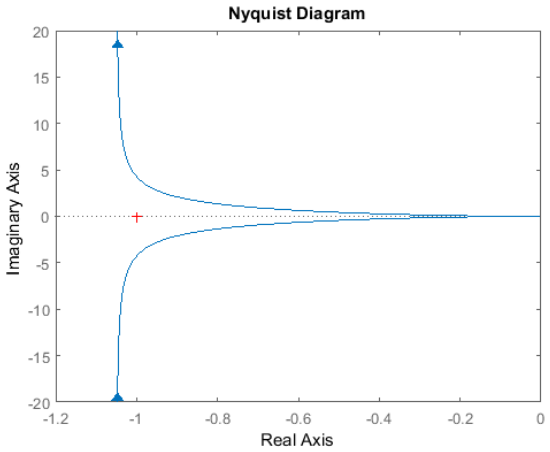

Figure 3: Nyquist plot when K=1

4. Find K so that $\zeta = \sqrt{(2)}/2$ for the closed loop system.

Using the root locus the value K at which ζ is 0.7071 is: 0.476.

5. Find phase and gain margins for this K.

```
G1new = zpk([],[0,-1,-20],20*K)
figure(5); margin(G1new)
```

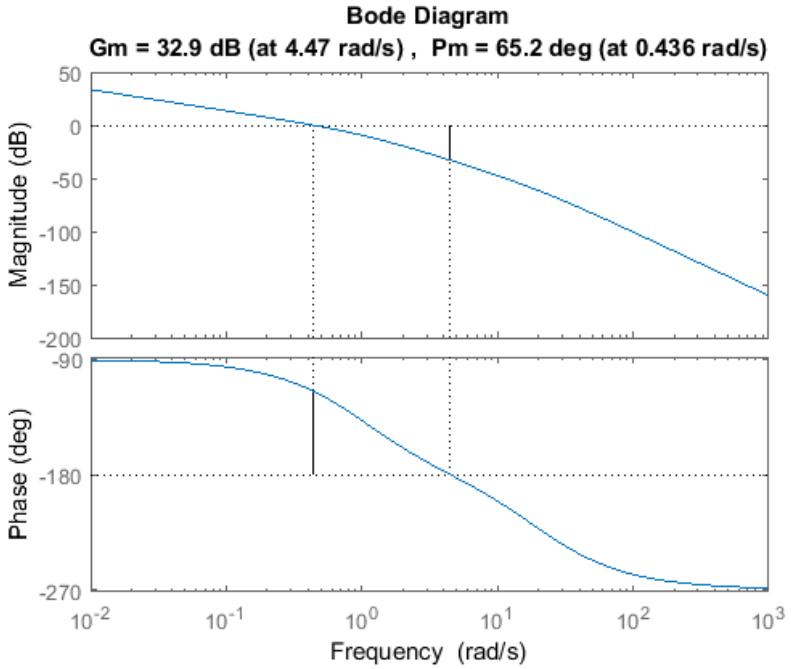

Figure 4: Phase and Gain Margin in Bode Plot

As shown in the updated bode plot, the $PM = 65.2^o$ and has a $GM = 32.9$DB

6. Sketch the step and ramp responses of the closed loop system for this K

```
G1tfnew = tf(G1new)
subplot(2,1,1); step(G1tfnew); %% create subplot for step
    function
ramps = tf([1,0],[1]);
subplot(2,1,2); step(G1tfnew/ramps); %% create subplot for
    ramp function
```

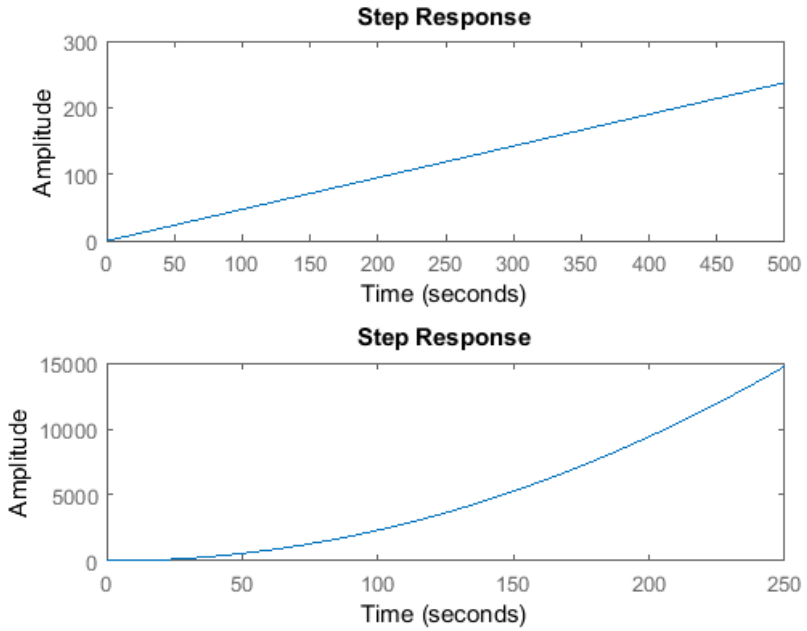

Figure 5: Step Response of Transfer function with K = 0.479

7. Discuss the connection between Kv, zeta, margins and the response of the closed loop system.

The value of Kv is 1, so the steady state velocity error is constant. Additionally the system is stable because of a positive phase and gain margin. Finally, the value of $\zeta = 0.7071$ corresponds to a gain of 0.427.